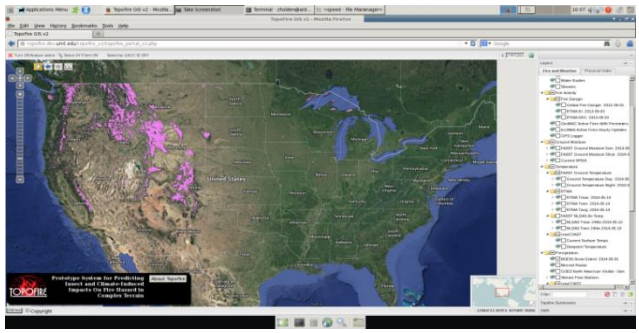
TOPOFIRE: A System for Monitoring Insect and Climate Induced Impacts on Fire Danger in Complex Terrain

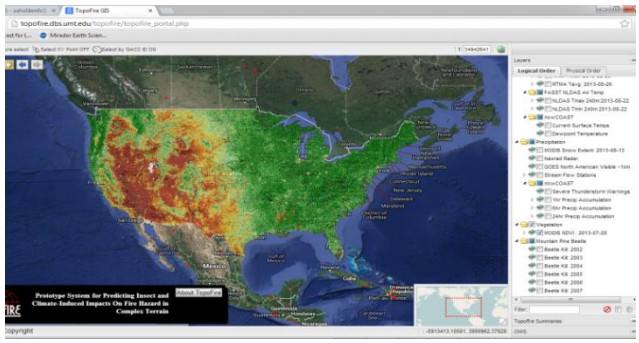
The fire environment is loosely defined by three factors: fuel, weather and topography. Both fuel and weather vary strongly both seasonally and spatially. Many weather factors such as temperature, humidity, wind, radiation, precipitation and snow cover influence ignition probability and regulate the behavior of that fire upon ignition. These conditions vary dramatically in complex terrain. However, operational fire management tools, such as the National Fire Danger Rating System (NFDRS) and the Wildland Fire Decision Support System (WFDSS) are applied at a single point, (usually the nearest remote automated weather station) and these conditions are assumed to be representative of the landscape-scale conditions where the decisions are being made. Operational fire danger and fire behavior assessment tools ignore fine-scale spatial variation in weather and this can have a pronounced effect on the decisions made using those tools.

To address the issues described above, we have developed an open source interactive web server called TOPOFIRE (topofire.dbs.umt.edu), designed as the next generation of the Wildland Fire Assessment System (WFAS). TOPOFIRE integrates very high resolution climate data, NASA imagery, and gridded FASST hydrologic model outputs with national decision support tools to provide spatial information critical to nearly every aspect of wildland fire management decision support. The primary goal of the system is to provide more finely resolved spatial information about fuel conditions in the wildland fire environment.

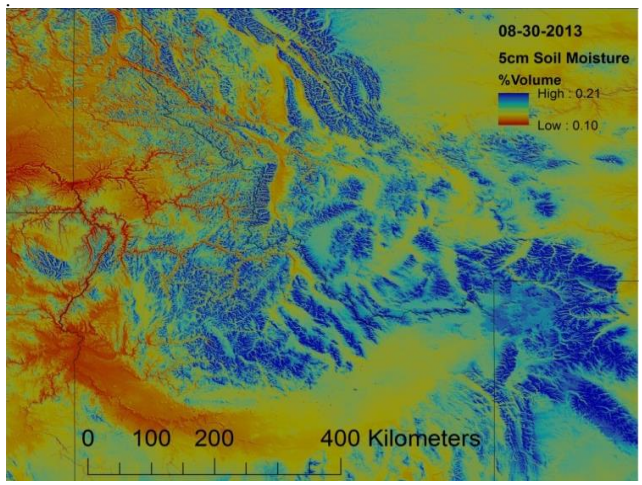
Data from thousands of low-cost temperature and humidity sensors distributed across the Pacific Northwest are used to downscale the National Land Data Assimilation System (NLDAS) dataset to 240 meter resolution. These terrain-corrected data, modeled wind and radiation data from WindNinja and MODIS snow extent data are used to drive the FASST hydrologic model. Daily duff and soil moisture maps are produced each day at 240 meter resolution. Fuel moisture and fire danger calculations are made using modeled near-surface air temperatures, to better account for the physical and topo-climatic influences on fire danger.



MODIS 8-day snow extent data are assimilated into TOPOFIRE and incorporated into fuel moisture and fire danger calculations.



MODIS 16-day day vegetation indices are used to calculate relative greenness, a key indicator of fire danger currently estimated using AVHRR in the Wildland Fire Assessment System.

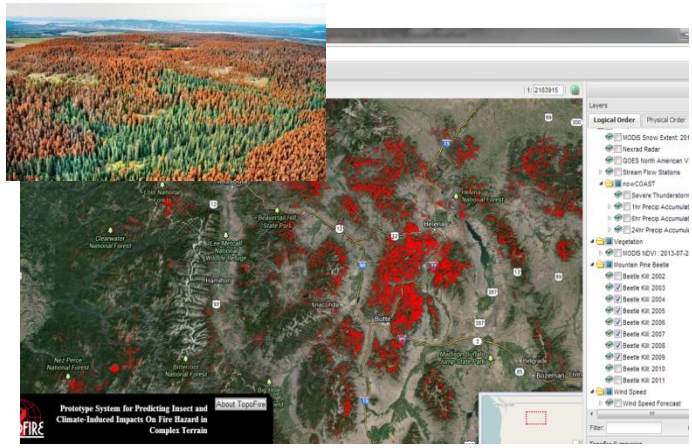


FASST modeled duff moisture output from TOPOFIRE, August 30th 2013.

Discovering and Demonstrating Innovative and Practical Applications of Earth Observations

Mapping Mountain Pine Beetle Mortality with MODIS imagery

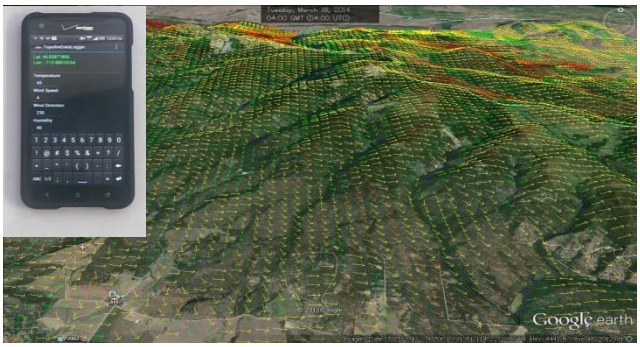
Recent Mountain Pine Beetle outbreaks are affecting the surface and canopy fuel distributions across millions of acres of Western US forests and these fuel changes can result in extreme fire behavior, particularly in the early "red" stages of attack. Fire managers currently rely on hand-drawn aerial survey maps for information on the location of beetle-killed areas. These maps generally represent last year's conditions, and surveys usually miss large areas each year.. Accurate, timely maps of historical and emerging insect-induced tree mortality are essential for safely and effectively managing wildland and prescribed fires. TOPOFIRE integrates aerial survey maps with MODIS VI time series to produce annual maps of MPB attack.



The BFAST algorithm is applied each year to MODIS vegetation index data and then combined with historical aerial survey data to produce maps of recent MPB-induce tree mortality. These maps and data are available on TOPOFIRE and will be integrated into fire behavior simulations performed through WFDSS for improved characterization of potential for extreme fire behavior.

Crowd sourced Data collection and Distribution via Smartphone

Smartphones have evolved into powerful GPS and camera enabled personal computers. TOPOFIRE harnesses smartphone technology by assimilating weather observations and photos collected during fire incidents. Additionally, firefighters will be able to request Windninja wind speed simulation forecasts as well as maps of fire danger and potential fire behavior. Outputs from simulations run on TOPOFIRE will be delivered to user phones in near real time.



The TOPOFIRE smartphone application assimilates weather observations and photos from wildfire incidents, which can be used by fire managers and fire weather forecasters. Users can also request WindNinja simulation and fire danger forecasts via phone in real time.

Impacts on Wildland Fire Decision Support

The TOPOFIRE modeling system will provide information for both strategic and tactical decisions on fire incidents. Data and models from TOPOFIRE will be integrated into both WFAS and WFDSS, the two primary national decision support systems in the US. will provide access to data and tools that are critical to nearly every aspect of wildland fire management. Firefighters will be able to interface with TOPOFIRE via smartphones, providing data to improve real-time models, and receiving corrected model outputs in real-time.

Strategic and tactical management impacts include:

- *Strategic resource placement prior to fire incidents*
- *predetermining fire management objectives*
- *Determine staffing requirements for initial attack of fire*
- *Improved modeling of wildfire spead and behavior that accounts for spatial variability in fuel conditions*
- *Rapid communication during fire incidents via smartphone applications*

Products and Tools developed through TOPOFIRE include:

- *Modified fire behavior models that assimilate user-defined gridded fuel moisture and weather grids*
- *Very high resolution gridded historical weather data*
- *Easy access to Historical NASA imagery*
- *Smartphone applications for Android and iOS*

Points of Contact:
Zachary Holden (USFS Region 1)
Project Principal Investigator
406-396-3151, zaholdenfs@gmail.com
TOPOFIRE web link: topofire.dbs.umt.edu

Applied Sciences Program

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